**PCT** WORLD INTELLECTUAL PROPERTY ORGANIZATION
International Bureau

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 6 :
**D04H 1/42, H05K 1/03 // D04H 1/64, 13/00, B32B 5/26, 17/02**

**A1**

(11) International Publication Number: **WO 99/49118**

(43) International Publication Date: 30 September 1999 (30.09.99)

(21) International Application Number: PCT/FI99/00215

(22) International Filing Date: 19 March 1999 (19.03.99)

(30) Priority Data:

| | | |
|---|---|---|
| 60/078,708 | 20 March 1998 (20.03.98) | US |
| 09/108,278 | 1 July 1998 (01.07.98) | US |

(81) Designated States: AU, BR, CA, CN, EE, JP, KR, NO, PL, RU, US, European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE).

Published
*With international search report.*

(71) Applicant *(for all designated States except US)*: AHLSTROM GLASSFIBRE OY [FI/FI]; Ahlströmintie 19, FIN–48600 Karhula (FI).

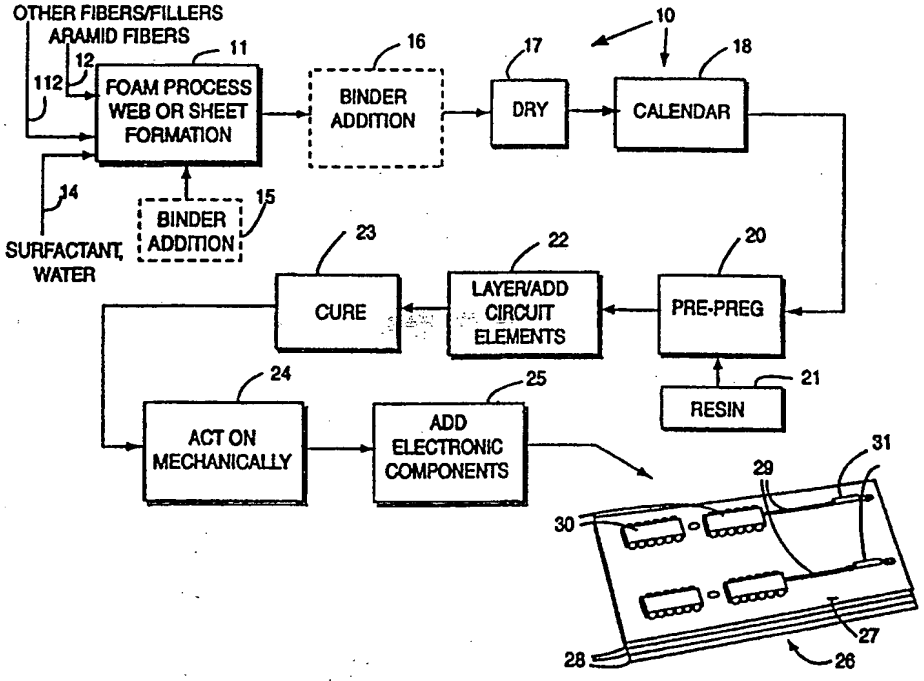
(72) Inventors; and
(75) Inventors/Applicants *(for US only)*: RÖKMAN, Kay [FI/FI]; Ahlstrom Glassfibre Oy, Ahlströmintie 19, FIN–48600 Karhula (FI). SABEL, Håkan [FI/FI]; Ahlstrom Glassfibre Oy, Ahlströmintie 19, FIN–48600 Karhula (FI).

(74) Agent: AHLSTROM MACHINERY OY; Patent Dept., P.O. Box 18, FIN–48601 Karhula (FI).

(54) Title: BASE WEBS FOR PRINTED CIRCUIT BOARD PRODUCTION USING THE FOAM PROCESS AND ARAMID FIBERS

(57) Abstract

A printed circuit board is made from at least one non–woven sheet or web layer comprising at least 10 % weight aramid fibers, with any balance substantially electrically non–conductive fibers, filler, and binder. The sheet or web is preferably made by the foam process, and at least about 10 % (e.g. at least about 60 %) of the aramid fibers utilized are aramid pulp fibers which have a number of advantages compared to the conventional straight aramid fibers. The web or sheet is preferably compressed so that it has a density of about 0.1–0.2 grams per cubic. centimeter; and the web or sheet has a basis weight of between about 20–120 grams per square meter. The web may also have a substantially electrically non–conductive binder such as PVA or an epoxy resin. A printed circuit board made using the aramid layers of non–woven webs or sheets is otherwise conventional, including a pre–preg material, electrically conductive circuit elements, and electronics.



# BASE WEBS FOR PRINTED CIRCUIT BOARD PRODUCTION USING THE FOAM PROCESS AND ARAMID FIBERS

## CROSS-REFERENCE TO RELATED APPLICATION

This application is based upon provisional application serial no. 60/078,708 filed March 20, 1998.

## BACKGROUND AND SUMMARY OF THE INVENTION

Printed circuit boards are conventionally made of primarily fiberglass fibers, with electrically non-conductive fillers. However there has been increasing interest in making printed circuit boards ("PCB") from aramid fibers since aramid fibers have a number of advantages over glass. In particular aramid has less electrical conductivity and therefore allows construction of a board that can have closer circuit density and is less susceptible to high frequency energy corruption. Also another outstanding characteristic of aramid is it has a better co-efficient of thermal expansion than glass. Aramid non-woven webs also have a smooth surface, and are superior in high temperature applications to glassfiber webs. Because of these advantages, duPont Chemical Company uses its own brand of aramid fiber ("THERMOUNT") in the production of printed circuit boards.

The duPont aramid PCBs are made using the conventional liquid laid process for non-woven web production using a foraminous element, such as a wire. In order to effectively make non-woven webs using aramid fibers by the liquid laid process, duPont uses a blend of different length and diameter aramid fibers, some of which may be fibrillated, in an

attempt to produce versatile and entirely commercially acceptable printed circuit boards. However there are numerous problems associated with the water laid process of production of aramid non-woven sheets or webs using conventional para aramid fibers (which are "straight").

Conventional aramid printed circuit boards, and layers formed of non-woven webs making up such boards, have a significant number of problems including the inability to randomly disperse the aramid fibers as uniformly as customers would like, and typically the aramid sheets are directional. This directionality creates different co-efficients of thermal expansion in the machine direction and the cross-machine direction in the finished product, and in tear characteristics relating to saturating the sheet. Also such boards are difficult to handle and require a significant amount of handling experience by customers, and they have an affinity to absorb moisture so that some customers must bake each roll in an oven to drive off humidity before it can be used. Also great care must be exercised during manufacturing to avoid chain wrinkles, lay flat, and other undesirable features which can be introduced during the forming, calendering, and rewinding processes. Also there is a recognized problem with electrically conductive particulate contamination, which reduces the electrical properties of the web produced.

According to the present invention a printed circuit board layer, the printed circuit board per se, and a method of producing printed circuit boards, are provided which overcome a number of the problems associated with conventional aramid-based printed circuit boards. By using two different techniques -- which techniques may be used separately, or to obtain optimum results are used together -- according to the invention, the uniformity of the aramid layers, and printed circuit boards produced thereby, can be significantly enhanced, including

reducing or substantially eliminating the directionality present in conventional prior art aramid boards. One technique according to the present invention is to use at least 10% by weight of aramid pulp fibers, and the other technique according to the invention is to use the foam process, such as described in co-pending applications serial no. 08/923,900 filed September 4, 1997 and serial no. 08;/923,250 filed September 4, 1997 (the disclosures of which are hereby incorporated by reference herein).

With respect to the utilization of aramid pulp fibers, aramid pulp fibers have different properties than the conventional para aramid fibers. The aramid pulp fibers are curly rather than straight, and can more readily fill openings between the straight fibers that are in the web or sheet, and provide more cross-over or contact points between the fibers, resulting in greater web strength and lower web directionality, while also minimizing the amount of conventional binder (such as PVA or epoxy resin) that is necessary. The pulp aramid fibers also enhance the possibility of calendering the web so as to enhance the density properties while minimizing the amount of binder. According to the present invention it is possible to obtain webs or sheets containing at least 10% aramid fiber that are between 20-120 grams per square meter, and have a density, enhanced by calendering, of between about 0.1-0.2 grams per cubic centimeter.

According to another aspect of the present invention, instead of -- or in addition to -- using aramid pulp fibers, the non-woven web or sheet may be made utilizing the foam process as described in the above-mentioned co-pending applications. The foam process is highly efficient in handling fibers like aramid fibers, allowing the formation of a much more uniform web, and allowing fiber blending to a much better extent

than webs produced by the water laid process. Fiber blending may be particularly important in the production of printed circuit board layers containing aramid fibers because aramid fibers are much more expensive than glass fibers, and in order to reduce the cost of aramid non-woven webs or sheets, while still obtaining most of the advantageous properties thereof, glass fibers, and conventional non-conductive fillers (such as plastic or glass particles) can be incorporated in the foam and are uniformly distributed in the final web produced. Also by using the foam process the density of the aramid fiber-containing webs or sheets produced may be much more closely regulated than when the water laid process is utilized, and the entire formation process is less expensive and more energy efficient.

Utilizing either of the two techniques according to the invention, printed circuit boards, and layers for printed circuit boards, may be produced containing at least 10% aramid fiber, and preferably at least 30% aramid fiber, and more preferably at least 50% aramid fiber, on up to substantially 100% aramid fiber. While substantially 100% aramid fiber boards and layers may be produced according to the invention, because of the expense of the aramid fibers typically there will be at least some other non-conductive fibers, like glass fibers, or non-conductive fillers, and aramid pulp fibers may also be blended with conventional para aramid (straight) fibers.

According to one aspect of the present invention a non-woven sheet or web is provided comprising at least 10% (and preferably at least 30%, more preferably at least 50%, up to substantially 100%, e.g. at least 90% aramid fibers) by weight aramid fibers, and any balance substantially electrically non-conductive fibers or fillers or binder, made by the foam process. The sheet or web may comprise at least about 10% straight

aramid fibers, or glass fibers, in addition to at least about 10% pulp aramid fibers. The web or sheet is typically compressed (as by using conventional calendering rolls) so that it has a density of between about .1-.2 grams per cubic centimeter, and a basis weight of between 20-120 grams per square meter. The web or sheet may also comprise at least about 1% by weight of a substantially electrically non-conductive binder, such as polyvinyl alcohol (PVA), epoxy resin, other conventional substantially non-conductive binders, or combinations thereof.

According to another aspect of the present invention a printed circuit board is provided comprising the following components: A plurality of substantially electrically non-conductive substrate layers. At least one of the layers comprising, prior to pre-preg, a non-woven layer comprising at least 10% by weight aramid pulp fibers. A pre-preg material, impregnating at least some of the layers. And, electrically conductive circuit elements provided on or between at least one of the substrate layers. Most printed circuit boards are made with between three to six layers, although a significant number of boards are also made using seven to eight layers, and there are also many boards made using nine or more layers. The pre-preg material is entirely conventional, and typically is epoxy resin, and the electrically conductive circuit elements are also completely conventional (as is their positioning), typically comprising copper strips, wires, or deposits, or like physical structures of other conductive materials such as silver. Typically the at least one layer containing the aramid pulp fibers is produced by the foam process, and may have at least about 50% by weight aramid pulp fibers prior to pre-preg. Each of the substrate layers may have a density of about .1-.2 grams per cubic centimeter prior to pre-preg, and the board typically further comprises a plurality of electronic components (such as computer

chips, diodes, resistors, etc.) connected to the board substrate, and to the electrically conductive circuit elements, using entirely conventional techniques.

According to another aspect of the present invention, a method of producing a printed circuit board is provided comprising the following steps: (a) Using the foam process producing a non-woven sheet or web comprising at least 10% by weight aramid fibers and the balance substantially electrically non-conductive fibers, filler, and binder. (b) Calendering the sheet or web from step (a). (c) Forming a printed circuit board layer using the sheet or web from step (b). (d) Forming a pre-preg from the layer of step (c) by impregnating the layer with resin or the like. (e) Combining the layer from step (c) with other substantially electrically non-conductive layers. (f) Providing electrically conductive circuit elements on or between at least one of the layers from step (c). And, (g) curing the pre-preg of steps (d)-(f) to produce a printed circuit board.

Step (b) is conventional, and typically is accomplished utilizing calendering rollers. The layering of the sheets or webs or produce the printed circuit board, of step (c), and the pre-preg formation of step (d), and combining a layer from step (c) with other substantially electrically non-conductive layers as in step (e), and providing the electrically conductive circuit elements as recited in step (f), as well as securing of step (g), are also all conventional. Also there preferably are the further conventional steps of (h) mechanically acting on the board from step (g); and (i) electrically and physically connecting electronic components to the board from step (h), and to the circuit elements.

Steps (a) and (b) are typically practiced to produce a sheet or web having a density of .1-.2 grams per cubic centimeter, and step (a) is typically practiced using at least about 30%, preferably at least about

50%, and perhaps at least 90%, by weight, aramid fibers, either all pulp, or all straight, or a combination of pulp and straight aramid fibers. For example step (a) may be practiced using at least 10% by weight aramid pulp fibers, and at least 10% by weight glass fibers, straight aramid fibers, or a mixture of glass and straight aramid fibers.

It is the primary object of the present invention to produce aramid fiber-containing layers, and printed circuit boards formed from one or more of such layers, which have enhanced utility and/or enhanced ease and reduced cost of production, compared to conventional aramid fiber-containing layers or boards. This and other objects of the invention will become clear from an inspection of the detailed description of the invention, and from the appended claims.

## BRIEF DESCRIPTION OF THE DRAWINGS

FIGURE 1 is a schematic view illustrating an exemplary method according to the present invention, resulting in the production of a printed circuit board; and

FIGURE 2 is an exploded schematic view of a circuit board according to the present invention without electronic components mounted thereon.

## DETAILED DESCRIPTION OF THE DRAWINGS

FIGURE 1 schematically illustrates a preferred method 10 of producing printed circuit boards, which have at least one layer containing aramid fibers. The first step according to the invention is the production of a web or a sheet using the foam process, as illustrated schematically at 11 in FIGURE 1. Aramid fibers from source 12, other fibers or fillers from

source 112, surfactant and water from source 14, and the like are provided, and the foam process is practiced preferably as described in serial no. 08/923,900 filed September 4, 1997 and serial no. 08/923,250 filed September 4, 1997, or the prior art mentioned therein. Typically the slurry has a consistency of at least about 5%, e.g. about 5-50%. Typically some binder will be added to the web, either prior to formation, as indicated schematically at 15 in FIGURE 1, and/or after formation, as indicated schematically at 16 in FIGURE 1. The binder may comprise at least about 1% by weight of a substantially electrically non-conductive binder, examples of known binders for that purpose being PVA, epoxy resin, and combinations thereof. By practicing the invention, however, because the web formation is much better (being more uniform, less directional, and having better strength properties) than webs of identical composition made by the water laid process, less binder is necessary (whether added at 15, 16, or both places) than is conventional, e.g. at least 25% less binder is necessary, in fact often less than 5% (e.g. 1-4.9%).

After web or sheet formation, the web or sheet is dried as indicated schematically at 17 in FIGURE 1 using conventional drying equipment (such as a drying oven), and the web is calendered as indicated schematically at 18, e.g. using conventional calendering rolls. Typically steps 11, 15 and 16, 17 and 18 will take place at one location, and then the final web or sheet produced (if a web is produced it is wound using conventional techniques, and if sheets are produced they are typically stacked for transport) is transported to another location where the other conventional steps for printed circuit board production take place.

The webs or sheets produced by the steps 11 and 15 through 18 typically have a density of between about .1-.2 grams per cubic

centimeter, and a basis weight of between about 20-120 grams per square meter.

The step schematically illustrated at 20 in FIGURE 1 is a pre-preg step, where the web or sheets from 18 are impregnated with epoxy resin from source 21 or the like, the impregnating resin being substantially electrically non-conductive. After pre-preg formation, the board is layered -- that is various layers are utilized (either the layers from step 18, or other layers produced by conventional techniques and of more conventional materials, such as glass fibers) are assembled together and circuit elements added, as schematically illustrated at 22. Circuit elements may be added in any conventional manner (e.g. screen printing, cladding, mechanical laydown and attachment, etc.) Then the layered intermediate board, with circuit elements, is cured in a conventional manner as in a curing oven, as illustrated schematically at 23 in FIGURE 1.

After curing at 23, the intermediate board is acted on mechanically -- as illustrated schematically at 24 in FIGURE 1 -- as is conventional, e.g. various holes being formed therein, shaping, shaving, texturing, enhancing exposure of circuit elements, or the like. Then the electronic components are added -- as schematically illustrated at 25 in FIGURE 1 -- to produce the final circuit board illustrated schematically at 26 in FIGURE 1. The electronic component addition step 25 is also conventional, various electronic elements that are to be utilized on the final board 26 being mechanically connected to the board and electrically connected to each other and/or circuit elements.

The board 26, being only very schematically illustrated in FIGURE 1, comprise the substrate 27 formed of multiple (typically between three and nine, but most typically between three and six) layers, illustrated schematically at 28 in FIGURE 1. According to the invention each of the

layers 28 may comprise at least 10% by weight (prior to pre-preg) aramid fibers (either straight or pulp), and preferably contain at least 30% aramid fibers, more preferably at least 50% fibers, and even more preferably at least about 90% aramid fibers (up to substantially 100% aramid fibers). However the layers 28 may have different percentages and types of aramid fibers therein, or some of the layers 28 may be conventional glass layers, or have other conventional constructions. However about 55-90% (by weight) or more aramid pulp fibers may be used (e.g. 60-90%).

The final circuit board 26 illustrated in FIGURE 1 also has electrically conductive circuit elements 29, which are strips, wires, or deposits of electrically conductive material, such as copper, silver, or other conventional conductive materials or blends thereof. The elements 29 connect electronic components together, and connect the board 26 to a power source, other boards, or other external components. FIGURE 1 schematically illustrates conventional chips 30 as electronic components, as well as diodes or resistors or capacitors 31, or the like. Any conventional electronic components can be utilized in the construction of the board 26 according to the invention.

The board 26 according to the invention will have less electrical conductivity than conventional glass boards, therefore can have closer circuit density and is less susceptible to high frequency energy corruption. Also because of a better co-efficient of thermal expansion, the board 26 can be expected to have longer life than an otherwise conventional board, can be used in higher temperature environments, and is otherwise advantageous.

In the web formation step 11, the appropriate type and percentage of fibers will be added to get the desired results. Preferably the aramid fibers added at 12 are at least 10% by weight pulp aramid fibers, e.g. at

least about 30%, more preferably at least about 60%, up to substantially 100%. Conventional straight aramid fibers may also be added instead of the pulp fibers at 12, or in addition to the aramid pulp fibers at 12, as indicated at line 13. For example at least about 10% straight aramid fibers may also be added, and/or at least about 10% glass fibers. Conventional fillers may also be utilized, as long as they are substantially electrically non-conductive, such as known glass and plastic particulate fillers.

FIGURE 2 schematically illustrates the board 26 before the mechanical activity at 24 and the electrical component addition at 25 from FIGURE 1, showing the components in an exploded view. Each of the layers 28 are preferably produced by the steps 11 and 15 through 18 (as well as by pre-preg at 20) and can have varying fiber compositions, but preferably each have at least 10% aramid fibers. The electrically conductive circuit elements are shown disposed between the layers 28, and may overlap the edges of the layers 28 for connection to external components, or to facilitate connection to components that will ultimately be mounted on the substrate 27. As is conventional, one or more of the layers 28 may be etched, mechanically sanded or handled, or otherwise acted upon to expose circuit elements 29 where necessary or desirable.

When aramid pulp fibers are utilized according to the present invention, preferably they are those sold under the trademark COSMORON, from Kolon Industries, Inc. of Seoul, South Korea. While fiber length is not necessarily significant, normally available fiber lengths that can be used are .5-2.5 mm. The pulp fibers -- illustrated highly schematically at 32 in FIGURE 2 for the upper layer 28 -- are curly, so that they readily fill the area between other fibers and/or fillers, and/or provide many cross-over points for contact between themselves or other

fibers, increasing web or sheet strength, and allowing reduction (e.g. by about 25% or more) of the amount of binder used for web formation.

It will thus be seen that according to the present invention a highly advantageous non-woven sheet or web for use in a printed circuit board construction, a printed circuit board, and a method of producing a printed circuit board, have been provided. While the invention has been herein shown and described in what is presently conceived to be the most practical and preferred embodiment thereof, it will be apparent to those of ordinary skill in the art that many modifications may be made thereof within the scope of the invention, which scope is to be accorded the broadest interpretation of the appended claims so as to encompass all equivalent structures and methods.

WHAT IS CLAIMED IS:

1. A non-woven sheet or web comprising at least 10% by weight aramid fibers, and any balance substantially electrically non-conductive fibers or filler or binder, or combinations thereof, made by the foam process.

2. A non-woven sheet or web as recited in claim 1 comprising at least about 50% aramid fibers.

3. A non-woven sheet or web as recited in claim 1 wherein the aramid fibers comprise at least 10% by weight pulp aramid fibers.

4. A non-woven sheet or web as recited in claim 1 wherein said web or sheet has been compressed so that it has a density of about .1-.2 $g/cm^3$.

5. A non-woven sheet or web as recited in claim 1 further comprising at least about 1% by weight of a substantially electrically non-conductive binder

6. A non-woven sheet or web as recited in claim 5 wherein the binder comprises PVA or epoxy resin or combinations thereof.

7. A non-woven sheet or web as recited in claim 3 further comprising at least about 10% straight aramid fibers, or glass fibers.

8. A non-woven sheet or web as recited in claim 1 comprising at least about 90% aramid fibers.

9. A non-woven sheet or web as recited in claim 1 having a basis weight of between 20-120 g/m$^2$.

10. A printed circuit board comprising:

a plurality of substantially electrically non-conductive substrate layers;

at least one of said layers comprising, prior to pre-preg, a non-woven layer comprising at least 10% by weight aramid pulp fibers;

a pre-preg material, impregnating at least some of said layers; and

electrically conductive circuit elements provided on or between at least one of said substrate layers.

11. A printed circuit board as recited in claim 10 further comprising a plurality of electronic components mounted on or between at least one of said substrate layers and electrically connected to said circuit elements.

12. A printed circuit board as recited in claim 10 wherein each of said substrate layers comprises a non-woven layer comprising at least 10% aramid pulp fibers prior to pre-preg.

13. A printed circuit board as recited in claim 10 wherein at least one of said substrate layers comprises at least about 60% by weight aramid pulp fibers prior to pre-preg.

14. A printed circuit board as recited in claim 12 wherein each of said substrate layers has a density of about .1-.2 g/cm$^3$ prior to pre-preg.

15. A printed circuit board as recited in claim 11 wherein said at least one non-woven layer with at least 10% aramid pulp fibers is produced by the foam process.

16. A method of producing a printed circuit board comprising the steps of:

(a) using the foam process producing a non-woven sheet or web comprising at least 10% by weight aramid fibers and the balance substantially electrically non-conductive fibers, filler, and binder;

(b) calendering the sheet or web from step (a);

(c) forming a printed circuit board layer using the sheet or web from step (b);

(d) forming a pre-preg from the layer of step (c) by impregnating the layer with resin or the like;

(e) combining the layer from step (c) with other substantially electrically non-conductive layers;

(f) providing electrically conductive circuit elements on or between at least one of the layers from step (c); and

(g) curing the pre-preg of steps (d)-(f) to produce a printed circuit board.

17. A method as recited in claim 16 comprising the further steps of (h) mechanically acting on the board from step (g); and (i) electrically and physically connecting electronic components to the board from step (h), and to the circuit elements.

18. A method as recited in claim 16 wherein steps (a) and (b) are practiced to produce a sheet or web having a density of .1-.2 g/cm$^3$, and wherein step (a) is practiced using a slurry having a solids consistency of at least about 5%.

19. A method as recited in claim 18 wherein step (a) is practiced using at least about 60% by weight aramid pulp fibers.

20. A method as recited in claim 18 wherein step (a) is practiced using at least 10% by weight aramid pulp fibers, and at least 10% by weight glass fibers, straight aramid fibers, or a mixture of glass and straight aramid fibers.

21. A method as recited in claim 16 wherein step (a) is practiced using at least about 60% aramid pulp fibers

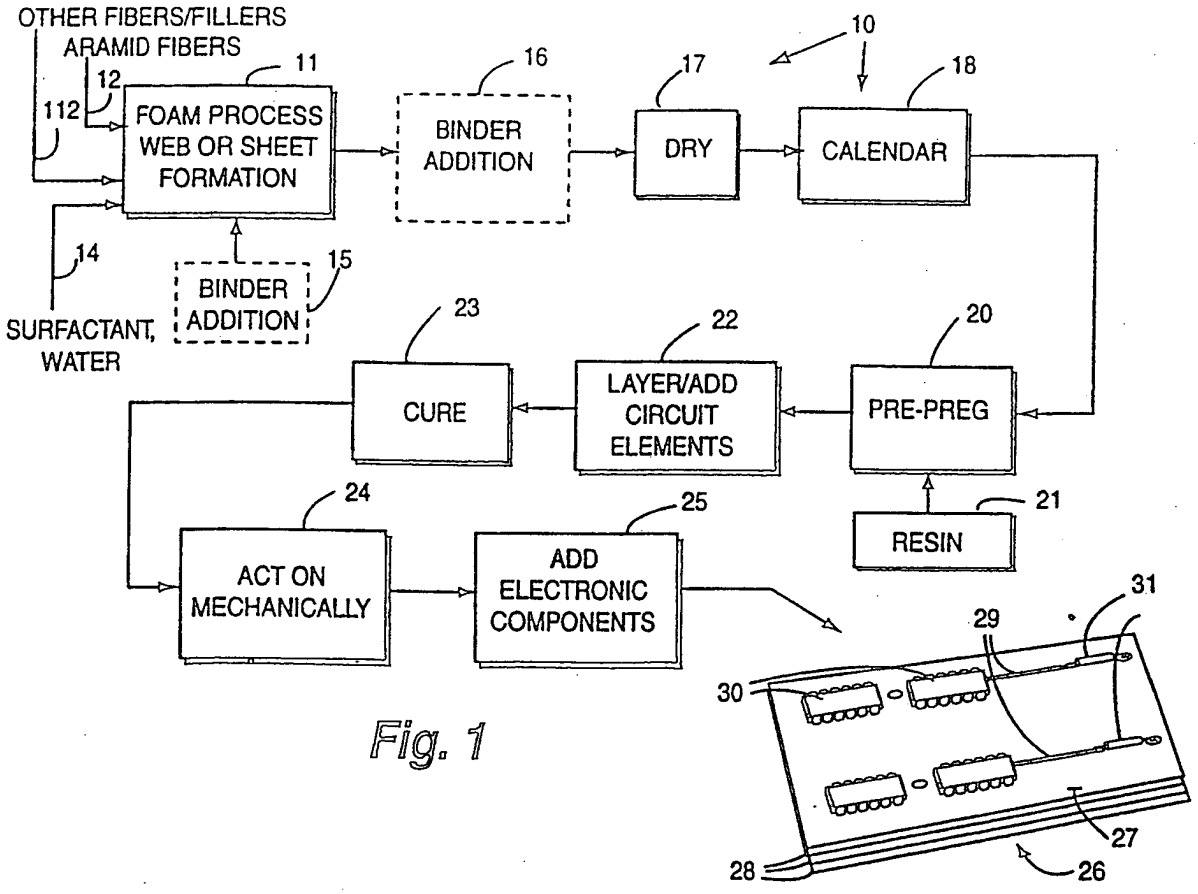



Fig. 1

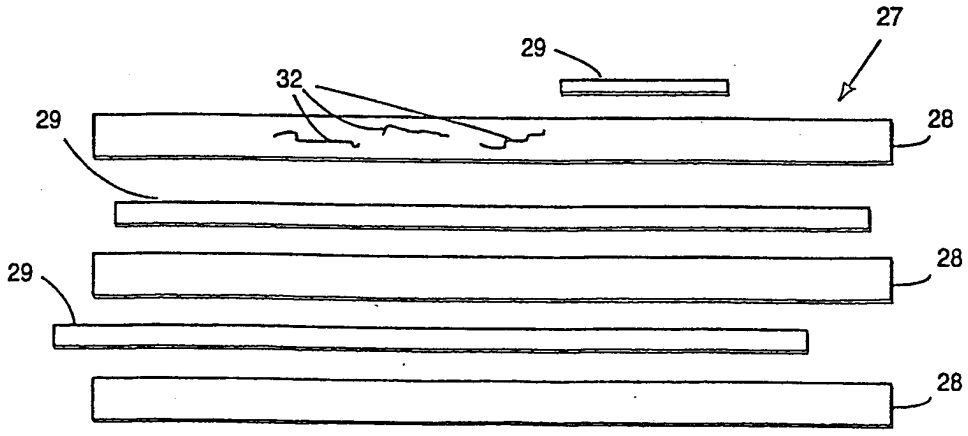



Fig. 2

# INTERNATIONAL SEARCH REPORT

International application No.
PCT/FI 99/00215

A. CLASSIFICATION OF SUBJECT MATTER

IPC6: D04H 1/42, H05K 1/03 // D04H 1/64, D04H 13/00, B32B 5/26, B32B 17/02
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC6: D04H, H05K

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

WPI, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

| Category* | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
|---|---|---|
| X | GB 2311304 A (SHIN-KOBE MACHINRY CO LTD), 24 Sept 1997 (24.09.97), page 4, line 25 - page 5, line 7; page 6, line 16 - page 7, line 7; page 8, line 4 - page 9, line 10, page 10, line 6 - line 14, page 11, line 3 - line 14, page 12, line 24 - page 14, line 15, page 16, line 14 - line 21 | 10-14 |
| Y | | 1-9,15-17,21 |
| A | | 19,20 |
| | -- | |
| Y | GB 1329409 A (WIGGINS TEAPE RESEARCH & DEVELOPMENT LIMITED), 5 Sept 1973 (05.09.73), claim 1 | 1-9,15-17,21 |
| A | | 18 |
| | -- | |

[X] Further documents are listed in the continuation of Box C. [X] See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" erlier document but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

| Date of the actual completion of the international search | Date of mailing of the international search report |
|---|---|
| 29 June 1999 | 13 -07- 1999 |
| Name and mailing address of the ISA:<br>Swedish Patent Office<br>Box 5055, S-102 42 STOCKHOLM<br>Facsimile No. +46 8 666 02 86 | Authorized officer<br>Teija Kurki / MR<br>Telephone No. +46 8 782 25 00 |

INTERNATIONAL SEARCH REPORT

International application No.
PCT/FI 99/00215

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

| Category* | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
|---|---|---|
| A | US 4883708 A (K. KARIYA ET AL), 28 November 1989 (28.11.89), column 1, line 54 - column 2, line 48, examples 1,2,7 and 8 | 1-17 |
| | -- | |
| A | US 4698267 A (E.W. TOKARSKY), 6 October 1987 (06.10.87), abstract | 1 |
| | -- | |
| A | US 4743495 A (H.N. LILANI ET AL), 10 May 1988 (10.05.88), abstract | 1,2 |
| | -- | |
| A | WO 9638026 A1 (DYNACO CORPORATION), 28 November 1996 (28.11.96), the whole document | 10-17 |
| | -- | |
| A | JP 6-270178 A (..), 27 Sept 1994 (27.09.94), abstract | 10-17 |
| | -- | |
| A | JP 3-279470 A (..), 10 December 1991 (10.12.91), abstract | 10-17 |
| | -- | |
| A | JP 63288722 A (..), 25 November 1988 (25.11.88), abstract | 10,16 |
| | -- | |
| A | JP 4-7895 A (..), 13 January 1992 (13.01.92), abstract | 10,16 |
| | -- | |
| | -------- | |

# INTERNATIONAL SEARCH REPORT

International application No.
PCT/FI 99/00215

**Box I** **Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)**

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

**Box II** **Observations where unity of invention is lacking (Continuation of item 2 of first sheet)**

This International Searching Authority found multiple inventions in this international application, as follows:

1. Claims 1-9 directed to a nonwoven web made by the foam process and which comprises at least 10 % aramid fibers.

2. Claims 10-17 directed to a printed circuit board and to a method for producing a printed circuit board.

see next sheet

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

**Remark on Protest**

☐ The additional search fees were accompanied by the applicant's protest.

☐ No protest accompanied the payment of additional search fees.

The special technical features of group 1 relate to a nonwoven web made by the foam process and which comprises at least 10% aramid fibers.

The special technical features of group 2 relate to a printed circuit board, which has a plurality of electrically non-conductive substrate layers, where at least one of the layers is a nonwoven layer comprising at least 10% aramid pulp fibers. A prepreg material impregnates at least some of the layers. Electrically conductive circuit elements are provided on or between at least one of the substrate layers. A method for producing such a printed circuit board is also claimed.

Document US 4883708 A1 shows a nonwoven sheet, which comprises at least 10% by weight of aramid fibers. Document GB 1329409 A shows a foam process for manufacturing a nonwoven web. It seems to be obvious for the man skilled in the art to combine these two techniques and achieve a nonwoven web claimed in the claim 1.

The invention according to claim 1 is therefore lacking an inventive step and the common special technical feature of groups 1 and 2 is thus not a special technical feature in the meaning of PCT Rule 13.2.

# INTERNATIONAL SEARCH REPORT

Information on patent family members

01/06/99

International application No.
PCT/FI 99/00215

| Patent document cited in search report | Publication date | Patent family member(s) | Publication date |
|---|---|---|---|
| GB 2311304 A | 24/09/97 | GB 9703590 D | 00/00/00 |
| | | JP 10131017 A | 19/05/98 |
| GB 1329409 A | 05/09/73 | AT 53773 A | 15/02/76 |
| | | AT 333116 B | 10/11/76 |
| | | BE 797713 A | 03/10/73 |
| | | CA 969395 A | 17/06/75 |
| | | DD 100990 A | 12/10/73 |
| | | DE 2254517 A | 18/10/73 |
| | | FR 2179149 A,B | 16/11/73 |
| | | JP 885177 C | 12/10/77 |
| | | JP 49013403 A | 05/02/74 |
| | | JP 52012283 B | 06/04/77 |
| | | NL 170654 B,C | 01/07/82 |
| | | NL 7215231 A | 09/10/73 |
| | | SE 395022 B,C | 25/07/77 |
| | | ZA 7208164 A | 26/06/74 |
| US 4883708 A | 28/11/89 | CA 1307453 A | 15/09/92 |
| | | EP 0295816 A | 21/12/88 |
| | | EP 0335721 A | 04/10/89 |
| | | JP 1086589 A | 31/03/89 |
| | | JP 1807960 C | 10/12/93 |
| | | JP 5013557 B | 22/02/93 |
| US 4698267 A | 06/10/87 | AU 584645 B | 01/06/89 |
| | | AU 4879885 A | 24/04/86 |
| | | BR 8505185 A | 29/07/86 |
| | | CA 1261109 A | 26/09/89 |
| | | DE 3566917 A | 26/01/89 |
| | | DK 478385 A | 20/04/86 |
| | | EP 0178943 A,B | 23/04/86 |
| | | SE 0178943 T3 | |
| | | GR 852531 A | 19/02/86 |
| | | HK 35489 A | 05/05/89 |
| | | IE 57021 B | 11/03/92 |
| | | MX 165242 B | 04/11/92 |
| | | PT 81339 A,B | 01/11/85 |
| | | SU 1672932 A | 23/08/91 |
| | | US 4729921 A | 08/03/88 |
| US 4743495 A | 10/05/88 | NONE | |
| WO 9638026 A1 | 28/11/96 | AU 5926396 A | 11/12/96 |
| JP 6-270178 A | 27/09/94 | NONE | |
| JP 3-279470 A | 10/12/91 | NONE | |
| JP 63288722 A | 25/11/88 | JP 1985121 C | 25/10/95 |
| | | JP 7020626 B | 08/03/95 |
| JP 4-7895 A | 13/01/92 | NONE | |